

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0504 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 07/27/00

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: GH2 ET TANK PRESSURIZATION FLOW CONTROL VALVES	MC280-0017-1301
	VACCO INDUSTRIES	80410-1301

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

VALVE, FLOW CONTROL, SOLENOID, GH2 PRESSURANT, NORMALLY HIGH FLOW (0.625 INCH DIA INLET, 1.0 INCH DIA OUTLET).

REFERENCE DESIGNATORS: LV56
LV57
LV58

QUANTITY OF LIKE ITEMS: 3

FUNCTION:

THREE FLOW CONTROL VALVES (ONE PER SSME SYSTEM) CONTROL THE FLOW OF PRESSURIZATION GAS FROM THE ENGINES TO THE HYDROGEN TANK TO MAINTAIN ULLAGE PRESSURE FOR TANK STRUCTURAL STABILITY AND SSME NPSP. THE UNPOWERED SOLENOID VALVE POSITION IS HIGH FLOW. VALVE POSITION (HIGH FLOW-70%/LOW FLOW-31%) IS CONTROLLED BY STIMULI FROM THE ORBITER MOUNTED SIGNAL CONDITIONERS. SIGNAL CONDITIONER INPUT COMES FROM ET MOUNTED ULLAGE PRESSURE TRANSDUCERS. A SINGLE COCKPIT SWITCH ALLOWS THE CREW TO REMOVE POWER FROM THE SOLENOIDS RESULTING IN ALL THREE VALVES OPERATING IN THE HIGH FLOW POSITION.

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LRU: VALVE, FLOW CONTROL (ON GH2)

ITEM NAME: GH2 FLOW CONTROL VALVES (LV56, 57, 58)

CRITICALITY OF THIS

FAILURE MODE: 1R2

FAILURE MODE:

FAILS TO STROKE TO HIGH FLOW POSITION DURING ENGINE OPERATION.

MISSION PHASE: LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:	102	COLUMBIA
	103	DISCOVERY
	104	ATLANTIS
	105	ENDEAVOUR

CAUSE:

MARGINAL POPPET FORCE BALANCE, BINDING, PIECE PART STRUCTURAL FAILURE, CONTAMINATION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

- A) FAIL
- B) PASS
- C) FAIL

PASS/FAIL RATIONALE:

A)

FAILS A SCREEN BECAUSE CHECKOUT WOULD INVOLVE INVASIVE TESTING (FORCE BALANCE TESTING REQUIRES FLOW THROUGH VERIFICATION).

B)

C)

FAILS C SCREEN BECAUSE OF POSSIBLE BACKFLOW OF CONTAMINATION INTO THE FCVS DURING GHE PREPRESSURIZATION OR GROUND ANTI-ICING PURGE.

- FAILURE EFFECTS -

(A) SUBSYSTEM:

NO EFFECT. REDUNDANT FLOW CONTROL VALVES (FCVS) WOULD COMPENSATE TO MAINTAIN ULLAGE PRESSURE AND NPSP.

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DURING RTLS ABORTS DUE TO ONE SSME OUT AND THE REMAINING ENGINES AT A 104% RPL, A SUBSEQUENT FLOW CONTROL VALVE FAILED TO THE LOW FLOW POSITION WILL CAUSE THE ET LH2 ULLAGE PRESSURE TO FALL BELOW THE REQUIRED CONTROL BAND (32 - 34 PSIA) LATE IN THE MAIN ENGINE OPERATION. TANK MINIMUM STRUCTURAL REQUIREMENTS AND NPSP ARE MAINTAINED.

(B) INTERFACING SUBSYSTEM(S):

SAME AS A.

(C) MISSION:

NO EFFECT.

(D) CREW, VEHICLE, AND ELEMENT(S):

SAME AS C.

(E) FUNCTIONAL CRITICALITY EFFECTS:

CASE 1:

1R/2 2 SUCCESS PATHS. TIME FRAME - ENGINE OPERATION.

- 1) A SINGLE FCV FAILS TO STROKE TO HIGH FLOW POSITION.
- 2) EITHER OF THE REMAINING TWO FCV'S FAILING TO STROKE TO HIGH FLOW POSITION OR LOSS OF GH2 PRESSURANT FROM EITHER OF THE REMAINING TWO ENGINES.

RESULTS IN INSUFFICIENT PRESSURIZATION GAS TO MAINTAIN LH2 ULLAGE PRESSURE IN THE REQUIRED FLIGHT CONTROL BAND (32 -34 PSIA). POSSIBLE VIOLATION OF TANK MINIMUM STRUCTURAL CAPABILITY REQUIREMENTS.

POSSIBLE LOSS OF CREW/VEHICLE.

CASE 2

1R/3 3 SUCCESS PATHS. TIME FRAME - ENGINE OPERATION.

- 1) A SINGLE FCV FAILS TO STROKE TO HIGH FLOW POSITION.
- 2) EITHER OF THE REMAINING TWO FCV'S FAILING TO STROKE TO HIGH FLOW POSITION OR LOSS OF GH2 PRESSURANT FROM EITHER OF THE REMAINING TWO ENGINES. FLIGHT RULES COVERING LH2 TANK PRESSURIZATION FAILURES DIRECT THE GROUND TO CHECK THE 2" DISCONNECT OUTLET PRESSURE, V41P1490A, TO DETERMINE IF THE FAILURE IS A PRESSURIZATION FLOW RESTRICTION OR AN ULLAGE LEAK. IN THE CASE OF A FLOW RESTRICTION, THE GROUND WILL DIRECT THE CREW TO MANUALLY THROTTLE THE SSME'S IN ORDER TO MAINTAIN THE SSME NET POSITIVE SUCTION PRESSURE (NPSP).
- 3) CREW FAILS TO THROTTLE SSME, OR THIRD LEG FAILS TO PROVIDE FULL FLOW CAPABILITY TO ET. LOSS OF ULLAGE SUPPLY COULD BE DUE TO FCV FAILED LOW, BLOCKAGE IN SYSTEM OR LEAKAGE.

THIS ASSUMES THAT THE FCV FAILURES OCCUR AFTER STRUCTURAL CRITICAL FAILURE POINT OF THE ASCENT PROFILE HAS OCCURRED. RESULTS IN INSUFFICIENT PRESSURIZATION GAS TO MAINTAIN LH2 ULLAGE PRESSURE IN THE REQUIRED FLIGHT

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CONTROL BAND (32 -34 PSIA). POSSIBLE VIOLATION OF TANK MINIMUM STRUCTURAL CAPABILITY REQUIREMENTS AND UNCONTAINED SSME SHUTDOWN DUE TO LOW NPSP.

POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE VALVE IS A SINGLE FLOW PATH, DUAL POSITION TYPE. IT IS SHIMMED TO ALLOW FLOW AT THE REQUIRED HIGH AND LOW FLOW SETTINGS. IT IS SPRING LOADED TO THE HIGH FLOW POSITION AND SOLENOID ACTUATED TO THE LOW FLOW POSITION. A LABYRINTH-DESIGN SEAL REDUCES THE POTENTIAL FOR MARGINAL POPPET FORCE BALANCE BY MINIMIZING ACTUATION FORCE REQUIRED FROM THE SOLENOID.

BINDING COULD OCCUR DUE TO CONTAMINATION OR GALLING BETWEEN THE POPPET SEAL (NITRIDED INCONEL) AND THE SLEEVE (440A CRES) OR BETWEEN THE ARMATURE (GOLD PLATED 430F CRES) AND THE SOLENOID FLANGE (430F CRES). THE POPPET SEAL IS NITRIDED AND THE ARMATURE IS GOLD PLATED TO PREVENT GALLING. CLEARANCE BETWEEN THE ARMATURE AND FLANGE IS 0.0005 INCH AND CLEARANCE BETWEEN THE SEAL AND SLEEVE IS 0.0004 INCH. NO FAILURE OF THIS TYPE HAS OCCURRED DURING PARTICLE IMPACT TESTING IN WHICH 10 MG OF CONTAMINANT WAS INJECTED DURING EACH TEST.

STRUCTURAL FAILURE OF THE POPPET SPRING (ELGILOY) WILL NOT RESULT IN FAILURE OF THE POPPET TO STROKE TO THE HIGH FLOW POSITION, SINCE A POSITIVE AERODYNAMIC FORCE ACTS TO OPEN THE POPPET. THE ONLY WAY THAT STRUCTURAL FAILURE COULD CAUSE FAILURE TO STROKE WOULD BE IF FAILED MOVING PIECES (AS DESCRIBED IN THE ABOVE PARAGRAPH) WERE TO BIND AT SLIDING INTERFACES DUE TO COCKING OR JAMMING.

SYSTEM CONTAMINATION IS MINIMIZED BY AN ET SCREEN, A PREVALVE SCREEN, A GSE DEBRIS PLATE, A GSE FILTER AND A GH2 FILTERS INSTALLED IN THE PRE-PRESSURIZATION AND EACH IN ENGINE LEG.

(B) TEST:

ATP

EXAMINATION OF PRODUCT

AMBIENT TESTS (GN2)

PROOF PRESSURE: VALVE HOUSING (9440 PSIA, TEMPERATURE CORRECTED)

TOTAL EXTERNAL LEAKAGE (800 PSIA)

ELECTRICAL CHARACTERISTICS

INSULATION RESISTANCE

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BONDING
DIELECTRIC STRENGTH
COIL RESISTANCE
COIL TEMPERATURE TEST

FLOW CALIBRATION VERIFICATION (GH2 AT 80 DEG F)
HI FLOW POSITION
INLET PRESSURE: 3300 PSIA
OUTLET PRESSURE: 800 PSIA MAXIMUM
LOW FLOW POSITION
INLET PRESSURE: 3300 PSIA
OUTLET PRESSURE: 800 PSIA MAXIMUM

FUNCTIONAL TEST
DEMONSTRATION DUTY CYCLE
INLET PRESSURE: 4,250 PSIA
PURGE FLOW TEMPERATURE: -130 DEG F
PERFORMANCE VERIFICATION (ELECTRICAL)

CERTIFICATION

FUNCTIONAL TESTS
DEMONSTRATION DUTY CYCLE
12 SETS OF INITIAL CONDITIONS:
GH2 AT -70 DEG F, +80 DEG F, +210 DEG F
1500 PSIA, 2500 PSIA, 3500 PSIA, 4500 PSIA
(EACH PRESSURE AT ALL THREE TEMPERATURES)

LIFE TESTS (10,000 CYCLES INCLUDING ATP AND QUALIFICATION TESTS)

OPERATIONAL CYCLES
INLET PRESSURE: 25 AND 3600 PSIA
INLET TEMPERATURE: 80 DEG F
PERFORMANCE VERIFICATION (ELECTRICAL AND FLOW)

AMBIENT CYCLES (5000 CYCLES)
INLET PRESSURE: 25 PSIA
INLET TEMPERATURE: AMBIENT
PERFORMANCE VERIFICATION (ELECTRICAL AND FLOW)

AT COMPLETION OF AMBIENT CYCLE TEST REPEAT PERFORMANCE
VERIFICATION (ELECTRICAL) AND ELECTRICAL CHARACTERISTICS TEST

SOLENOID POWERED LIFE TEST
50 HOURS MINIMUM
INLET PRESSURE: 25 PSIA
VALVE BODY TEMPERATURE: +140 DEG F
ELECTRICAL POWER: +32 VOLTS DC

VIBRATION
TRANSIENT: 5 TO 35 HZ AT +/- 0.25 GS

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RANDOM: 13.3 HOURS IN EACH OF THREE AXES AT 600 PSIG GHE AT AMBIENT TEMPERATURE

DESIGN SHOCK (PER MIL-STD-810)

THERMAL SHOCK (100 CYCLES)

BODY TEMPERATURE: AMBIENT

INLET PRESSURE: 4500 PSIA

INLET TEMPERATURE: +70 DEG F TO -160 DEG F TO +80 DEG F

BURST TEST

19,340 PSIA AT 300 DEG F

GROUND TURNAROUND TEST

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION

ALL INCOMING MATERIALS ARE INSPECTED FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL

ASSEMBLIES ARE MAINTAINED TO CLEANLINESS LEVEL 400 FOR HYDROGEN. CORROSION PROTECTION PROVISIONS ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

ALL PARTS ARE CLEANED PRIOR TO ASSEMBLY. DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. MANDATORY INSPECTION POINTS ARE ESTABLISHED TO VERIFY ASSEMBLY PROCEDURES. TORQUE REQUIREMENTS AND ELECTROCHEMICAL ETCH MARKINGS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES

WELDING, INCLUDING SECTIONING WELD SAMPLES, AND SOLDERING ARE VERIFIED BY INSPECTION. ALL SOLDER JOINTS, INSULATED WITH HEAT SHRINK SLEAVINGS, ARE VERIFIED PER APPLICABLE REQUIREMENTS AND POTTED TO PROVIDE STABILITY. ELECTRO POLISHING AND PASSIVATION ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

WELDS ARE VISUALLY EXAMINED AND VERIFIED BY X-RAY AND DYE PENETRANT INSPECTION. RADIFLOW INSPECTION IS PERFORMED ON SOLENOID ASSEMBLY.

TESTING

ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPMENT IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

THE ORIGINAL GH2 FLOW CONTROL VALVE CONFIGURATION (MC280-0017-0015) HAD SUBSTANTIAL GROUND AND FLIGHT FAILURE HISTORY. AS A RESULT, THE VALVE HAS

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BEEN COMPLETELY REDESIGNED TO A NEW CONFIGURATION (-0361) WHICH HAS BEEN USED SINCE STS-41D. THE REDESIGNED VALVE HAS HAD NO ACCEPTANCE TEST, QUALIFICATION TEST, FIELD OR FLIGHT FAILURES ASSOCIATED WITH THIS FAILURE MODE.

PREVIOUS CONFIGURATION FAILURE HISTORY

THE VALVE FAILED TO OPEN FULLY AT THE 2370TH CYCLE OF THE OPERATIONAL CYCLIC LIFE TEST WHICH REQUIRES 3390 CYCLE (REF. CAR AD7527). THE CYCLE RATE WAS CHANGED FROM A ONE SECOND INTERVAL TO 20 SECONDS. AT THIS CYCLE RATE THE VALVE PERFORMED NORMALLY. THE VALVE WAS RETESTED AND FAILED ON THE 2829TH CYCLE (REF. CAR AD7544). IT WAS CONCLUDED THAT THE POPPET BEARING FRICTION INCREASES WHEN THE VALVE IS CYCLED AT SHORT INTERVALS. NO CORRECTIVE ACTION FOR THE VALVE WAS REQUIRED. THE TEST METHOD WAS CHANGED TO INCREASE THE DWELL TIME FROM ONE TO TEN SECONDS. NOTE THAT THE AVERAGE DWELL PERIOD DURING FLIGHT IS GREATER THAN 20 SECONDS.

DURING ATP THE FLOW CONTROL VALVE FAILED TO OPEN WHEN THE SOLENOID WAS DEENERGIZED. A FUNCTIONAL TEST WAS BEING RUN WITH HOT G02 AT 360 DEG F AND A PRESSURE BETWEEN 3600 AND 4200 PSI. FOLLOWING VALVE DISASSEMBLY/REWORK/RETEST, THE VALVE EXPERIENCED SIMILAR FAILURES (REF CARS AB8200, AB8239, AB8256, AB8522, AB8606). IT WAS CONCLUDED THAT THIS VALVE CONFIGURATION (-0020) AND ITS COMBINATION OF MATERIAL IS NOT CAPABLE OF WITHSTANDING THE SPECIFICATION ENVIRONMENT OF HIGH PRESSURE FLOW OF HOT G02. A NEW TYPE IV CONFIGURATION (-0024) WAS QUALIFIED THAT WILL MINIMIZE THE RECURRENCE OF THIS FAILURE.

SEVERAL FAILURES OF THE VALVE FAILING TO CYCLE HAVE OCCURRED. A RELIEF HOLE FOR THE ARMATURE SHAFT WAS BORED OFF CENTER CAUSING THE SOLENOID SHAFT TO DRAG (REF DR AC8093). THE SOLENOID WAS REWORKED AND SUCCESSFULLY PASSED ATP. FAILURE OF THE VALVE TO PULL IN OCCURRED DURING TESTING AT WHITE SANDS (REF DR AC8819, AC8820, AC8245). SYSTEM CONTAMINATION WAS DETERMINED TO BE THE CAUSE AND NO CORRECTIVE ACTION WAS TAKEN. THIS CONDITION IS ATP SCREENABLE.

THE VALVE HAS EXPERIENCED FAILURES IN WHICH LOWER THAN MAXIMUM FLOW RATE OCCURRED (REF. CAR AC0171, AC5467, AC5477 AND DR AB6888, AC6021, AC9607). THESE FAILURES OCCURRED DURING CYCLING AND WERE ATTRIBUTED TO BINDING OR CONTAMINATION. UNITS WERE CLEANED, REWORKED AND SUCCESSFULLY RETESTED.

A FLOW ANOMALY WAS EXPERIENCED DURING STS-1 FRF (REF DR AB9128) AND WAS EVIDENCED BY A DROP IN ENGINE HEAT EXCHANGER OUTLET PRESSURE. TROUBLESHOOTING WAS PERFORMED BY IPR MPS-2-01-0122 AGAINST OMI S0014. NO ANOMALOUS CONDITION COULD BE FOUND.

DURING STS-1 SSME OPERATION (REF CAR 01F043), A LOWER THAN NORMAL FLOW OCCURRED THROUGH THE #1 ENGINE GO2 FLOW CONTROL VALVE. THIS IS A REPEAT OF THE MALFUNCTION EXPERIENCED DURING FRF (REF DR AB9128). THE FAILURE MODE WAS VERIFIED BUT NO DAMAGE OR OUT OF TOLERANCE CONDITIONS WERE FOUND. LARGER ORIFICES HAD BEEN INSTALLED TO MEET HIGHER THAN ATP FLOW RATE REQUIREMENTS. THE LARGER ORIFICES INCREASED THE POPPET INLET PRESSURE, FLOW, AND CLOSING LOADS, SUCH THAT THE POPPET OPENING SPRING FORCE WAS UNABLE TO FULLY OPEN THE POPPET. THE VALVE WAS REFURBISHED AND RETESTED TO CONFIRM THAT THIS

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VALVE WOULD FUNCTION PROPERLY WITH AN ADEQUATE FUNCTIONAL MARGIN. A NEW SPRING AND SHIMS WERE USED TO OVERCOME THIS CONDITION.

DURING STS-5 THE ENGINE #3 FLOW CONTROL VALVE STROKED LESS THAN ONE THIRD OPEN WHEN DEENERGIZED AT APPROXIMATELY T+2 SEC (REF. CAR 05F003). THE VALVE FULLY OPENED AT APPROXIMATELY T+35 SEC. WHEN ENGINE THROTTLING REDUCED THE VALVE INLET PRESSURE TO 3100 PSIA. THE VALVE FUNCTIONED NORMALLY DURING THE REMAINDER OF THE FLIGHT. THERE WERE NO INDICATIONS OF IGNITION SPOTS, SCRATCHES OR CONTAMINANTS. TYPICAL FRETTED AREAS WERE FOUND ON THE SEAL AND CORRESPONDING SLEEVE BEARING SURFACES. IT WAS CONCLUDED THAT THE VALVE FAILURE WAS DUE TO THE SAME CAUSE FOR FAILURE OF SSME #1 VALVE DURING STS-1 (REF. CAR 01F043). NO FAILURE ANALYSIS WAS PERFORMED.

A FLOW CONTROL VALVE FAILED TO OPEN COMPLETELY DURING STS-6 WHEN THE CLOSE COMMAND WAS REMOVED 6 OUT OF 26 TIMES DURING THE FIRST 110 SEC OF FLIGHT (REF. CAR 06F008). THIS PROBLEM IS SIMILAR TO PREVIOUS FLIGHT PROBLEMS (REF. CARS 01F043, 05F003). IT WAS DETERMINED THAT THIS TYPE OF FAILURE WAS THE RESULT OF MARGINAL NET OPEN FORCE ON THE POPPET WHICH WAS NOT PROPERLY SCREENED DURING ATP. NO FURTHER ACTION WAS TAKEN.

DURING STS-9 ASCENT, A FLOW CONTROL VALVE FAILED TO OPEN FULLY (REF. CAR 09F002). A COMPLETE REDESIGN WAS ACCOMPLISHED (-0361 CONFIGURATION). ALL GH2 FLOW CONTROL VALVES WERE REPLACED WITH THIS NEW CONFIGURATION.

GENERAL SYSTEM CONTAMINATION

GENERAL MPS SYSTEM CONTAMINATION HAS OCCURRED WHICH MAY LODGE ANYWHERE IN THE SYSTEM CAUSING THIS FAILURE MODE (REFERENCE THE FOLLOWING PARAGRAPHS).

CONTAMINATION FAILURES HAVE OCCURRED AT ALL PHASES OF MANUFACTURING AND PARTS REPLACEMENT. IN ALL CASES, STRICT ADHERENCE TO CLEANLINESS CONTROL PROCEDURES IS THE PRIMARY METHOD OF CONTAMINATION PREVENTION.

NUMEROUS LARGE PARTICLES OF BLACK RUBBER MATERIAL WERE FOUND DURING A POST FLIGHT EXAMINATION OF THE LH2 17 INCH DISCONNECT OF OV099 (FLIGHT 7, REFERENCE CAR AC9800). THE LO2 AND LH2 SYSTEMS OF ALL VEHICLES WERE EXAMINED. NO RUBBER WAS FOUND IN ANY OTHER VEHICLES. AFTER EXTENSIVE INVESTIGATION THE ORIGIN WAS NOT DETERMINED.

METAL SHAVINGS HAVE BEEN DISCOVERED IN LINES AND COMPONENTS, WHICH WAS MOST LIKELY GENERATED WHEN THEY WERE CUT OUT AND/OR REPLACED (REFERENCE CARS AC9868, A9654, AC2210, AB1706; DR AD2226). METHODS ARE BEING REVISED TO MINIMIZE PARTICLE GENERATION WHEN INSTALLING/REPLACING COMPONENTS, LINES, AND FITTINGS REQUIRING WELDED OR BRAZED JOINTS (PRODUCT QUALITY IMPROVEMENT COUNCIL). PERSONNEL HAVE BEEN CAUTIONED. PROCEDURES HAVE BEEN REVISED TO IMPROVE CLEANLINESS MAINTENANCE DURING COMPONENT BUILD UP AND REWORK (REFERENCE MCR 12512). SUPPLIER DOCUMENTS/PROCEDURES HAVE BEEN REVIEWED AND CLEANLINESS MAINTENANCE PROCEDURES HAVE BEEN IMPROVED.

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A PIECE OF A BRAZING PREFORM LODGED IN A 2-WAY SOLENOID VALVE ON OV-099 AT PALMDALE CAUSING A LEAKAGE FAILURE (REFERENCE CARS AC2111, AB2538). STEEL AND ALUMINUM PARTICLES CAUSED EXCESSIVE LEAKAGE ON THE 850 PSIG HELIUM RELIEF VALVE (REF CAR AC2229). FOR BOTH FAILURES CORRECTIVE ACTION WAS TO ADD SPECIAL PURGE PORTS TO THE MPS HELIUM PANEL ASSEMBLIES TO IMPROVE THE QUALITY OF FINAL CLOSEOUT BRAZES.

SEVERAL FOREIGN MATERIALS WERE INTRODUCED INTO THE MPS SYSTEM DURING MANUFACTURE AND PARTS REPLACEMENT. EXAMPLES ARE: GLASS CLOTH IN LINE TO PREVENT TRAVEL OF CHIPS DOWN LINE; POLYSTYRENE OBJECT TO HOLD VALVE

POPPET OPEN WHILE PURGING; COTTON SWAB MATERIAL AND GLASS BEADS FROM CLEANING OPERATION; MISCELLANEOUS PLASTIC; FOAM; AND TAPE (REFERENCE CARS AB4751, AC2217, AC6768, AC9868, MPS3A0005, AC7912, AB0530). MATERIALS WERE REMOVED AND PERSONNEL WERE CAUTIONED. A HIGH FLOW DELTA P TEST AT PALMDALE WAS ADDED TO VERIFY THAT LINES WERE NOT PLUGGED. GRIT BLASTING (GLASS BEADS AND SAND USED TO CLEAN A LINE) IS NO LONGER PERFORMED. PROCEDURES HAVE BEEN REVISED TO IMPROVE CLEANLINESS MAINTENANCE DURING COMPONENT BUILD UP AND REWORK (REFERENCE MCR 12512). SUPPLIER DOCUMENTS/PROCEDURES HAVE BEEN REVIEWED AND CLEANLINESS MAINTENANCE PROCEDURES HAVE BEEN IMPROVED.

ONE PIECE OF WIRE WAS FOUND IN THE INTERNAL RELIEF VALVE OF THE LO2 PREVALVE ON OV103 (REFERENCE CAR AC9101). THE SOURCE OF THE CONTAMINATION WAS NEVER FOUND, BUT IT WAS BELIEVED TO BE FROM THE ET. OTHER CONTAMINATION HAS BEEN FOUND ON THE FEEDLINE SCREENS, SUCH AS AN UNIDENTIFIED ROUND OBJECT AND VARIOUS METALLIC PARTICLES (REFERENCE CARS AB0529 AND AB0530). THE SOURCE OF CONTAMINATION WAS UNDETERMINED. BORESCOPE EXAMINATIONS ARE CONDUCTED ON ALL FEEDLINE SCREENS EVERY FIFTH FLIGHT TO VERIFY CLEANLINESS. CONTAMINATION WAS REMOVED WHEN POSSIBLE.

CURRENT DATA ON TEST FAILURE, FLIGHT FAILURE, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

(E) OPERATIONAL USE:

IF THE LH2 NPSP DROPS BELOW THE PRE-FLIGHT ACCEPTED LEVELS (PER FLIGHT RULES), THE CREW WILL MANUALLY THROTTLE THE ENGINES TO KEEP THE NPSP HIGH ENOUGH TO PREVENT LH2 TURBOPUMP CAVITATION.

- APPROVALS -

S&R ENGINEERING	: W.P. MUSTY	:/S/ W.P. MUSTY
S&R ENGINEERING ITM	: P. A. STENGER-NGUYEN	:/S/ P.A. STENGER-NGUYEN
DESIGN ENGINEERING	: CHARLES EBERHART	:/S/ CHARLES EBERHART
MPS SUBSYSTEM MGR.	: TIM REITH	:/S/ TIM REITH
MOD	: JEFF MUSLER	:/S/ JEFF MUSLER
USA SAM	: MICHAEL SNYDER	:/S/ MICHAEL SNYDER

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USA ORBITER ELEMENT	: SUZANNE LITTLE	:/S/ SUZANNE LITTLE
NASA SR&QA	: BILL PRINCE	:/S/ BILL PRINCE